THE FLORA OF THE EDGEHILL RIDGE NEAR WILLOW GROVE AND ITS ECOLOGY.

BY ALEXANDER MAC ELWEE.

The village of Willow Grove, Montgomery county, Pa., is situated near the eastern edge of the Chester Valley limestone formation, and just at the northern base of one of the highest points of the Potsdam sandstone, commonly known as the Edgehill ridge. This ridge is part of an almost continuous belt of sandstone, quartzite and conglomerate rocks, which extends from the Delaware river near Trenton almost to the Schuylkill river. The section of the belt studied extends from the village of Willow Grove southeast about one mile, then southwest for about five miles, terminating at a point one mile southwest of the village of Edgehill. The average elevation of this ridge is about 400 feet. This elevated region is an important factor in determining the flow of the streams in its neighborhood. Sand Run, rising about a half-mile east of Rubicam, drains the valley between this ridge and the hills of the same formation on the north and unites with the Wissahickon on the west side of Fort Hill. Various little streams starting on the south side at Laverock, Edgehill, Weldon and Abington, unite a short distance above Jenkintown and form the main volume of Tacony creek. The southeast, east and northeast sides are drained by the Pennypack creek and its tributaries, Paul's Brook, Terwood Run and other minor streams. Numerous good roads traverse the region in different directions, and many fine views of the surrounding country may be obtained.

The flora of this ridge is very interesting, owing to its difference from that of the surrounding country. It is a flora peculiar to many barren districts on the Atlantic seaboard which contain numerous species and varieties.

The plants of this region resolve themselves into three societies or associations of species. These are as follows:

1. Sunshine plants:
   (*a*) Roadside,
   (*b*) Dry open woods,
   (*c*) Introduced annuals of the cultivated fields.
2. Shade plants.
3. Bog plants.

1. Sunshine Plants.—The old road leading over the hill near Willow Grove is an excellent place for the study of this society. A great variety of plants are found here in bloom, from the first early violets of spring until the last asters and golden-rods of autumn. The varied colors and scents of the Virginia goats-beard, golden ragweed, clumps of pink azaleas, lousewort, blue-eyed grass, fragrant pennyroyal, bracken ferns and kindred plants make the road gay in early summer. Later, the many forms of sedges, grasses, tick-seeds, and compositæ interest the lover of plants. It is interesting to note the number of young trees of rock oak, red oak, tulip poplar, sassafras, mocker-nut, hickory and others which are springing up among the belt of blackberries skirting the road. Wagons passing at long intervals just manage to keep the track open and prevent the forest from reclaiming its own. The following is a select list of plants of this society:

Pteris aquilina,
Agrostis alba,
Danthonia spicata,
Panicum pubescens,
Panicum sphærocarpon,
Carex virescens,
Sisyrinchium graminoides,
Rubus Canadensis,
Rubus villosus,
Baptisia tinctoria,
Lespedeza hirta,
Ascyrum hypericoides,
Helianthemum majus,
Viola communis,
Viola dentata,
Viola emarginata,
Viola fimbriatula,
Viola sagitatta,
Viola villosa,
Chamænerion angutifolium,
Lysimachia nummularia,
Sabbatia angularis,
Pedicularis Canadensis,
Campanula rapunculoides,
Adopogon Virginicum,
Aster ericoides,
Aster lateriflorus,
Bidens comosa,
Eupatorium aromaticum,
Gnaphalium obtusifolium,
Hieracium Gronovii,
Hieracium scabrum,
Solidago bicolor,
Solidago nemoralis.

(*b*) The dry open woods contain a society of plants, some of which are frequently met with along the road. Huckleberry Hill, so named by me from the variety and abundance of these plants found there, may be taken as a type locality. The species of plants are few and comprise the following:

Carex nigro-marginata,
Scleria pauciflora,
Hypoxys hirsuta,
Pogonia verticillata,
Comptonia peregrina,
Quercus Marylandica,
Quercus minor,
Rubus hispidus,
Cracca Virginiana,
Linum striatum,
Linum Virginianum,
Gaylussacia resinosa,
Gaylussacia frondosa,
Vaccinium atrococcum,
Vaccinium vacillans,
Vaccinium stamineum,
Kalmia augustifolia,
Kalmia latifolia,
Dasystoma flava,
Gerardia tenuifolia,
Aster patens,
Aster undulatus,
Aster undulatus triangularis,
Chrysopsis mariana,
Sericocarpus asteroides.

(*c*) The weeds of the cultivated fields will form the basis of later study.

2. Shade or Forest Plants.—The woods of the hill consist principally of second-growth rock-chestnut oak, with a sprinkling of white and red oak. Beech trees are also quite numerous, and in the thicker portions are a few tulip trees conspicuous by their tall, straight, light-colored trunks. Along the outskirts are juniper, sassafras, white and shellbark hickory, cherries and dogwood.

The undergrowth consists of arrow-wood, young beeches and high bush huckleberries, while clambering up and over the trees are tangled masses of frost-grape and briar. At the highest point of the hill the woods have been cut over in recent years, hence the timber is very thin and averages about twelve feet in height. Further north, nearer the village, the timber is heavier and is at its best in the woods on the northeast side of the road. All these woods give shelter to herbaceous plants according to their density and depth of vegetable mould. The following plants, among others, may be found:

Adiantum pedatum,
Panicum Porterianum,
Smilax herbacea,
Polygonatum biflorum,
Cypripedium acaule,
Populus grandidentata,
Agrimonia hirsuta,
Aronia nigra,
Geranium maculatum,
Viola pubescens,
Viola sororia,
Sanicula Canadensis,
Deringa Canadensis,
Chimaphila maculata,
Chimaphila umbellata,
Pyrola rotundifolia,
Monotropa uniflora,
Hypopitys Hypopitys,
Pieris mariana,
Lycopus Virginicus,
Chelone glabra,
Galium triflorum,
Galium lanceolatum,
Viburnum acerifolium,
Aster divaricatus,
Aster Lowrieanus,
Aster Lowrieanus lancifolius,
Aster macrophyllus pinguifolius,
Nabalus trifoliatus.

3. Bog Plants.—This society of plants is very interesting, not in its size, but in its peculiar flora. The little bog of this region is in the centre of a three-acre field. The trees in it consist mainly of sweet bay, *Magnolia Virginiana*, willows and alders. The rills from the base of the hill all centre here. At different times in the year the following plants may be found in bloom:

Panicum sphagnicolum,
Panicum longifolium,
[1] *Agrostis altissima*,
Dulichium arundinaceum,
Eleocharis tuberculosa,
Rhyncospora alba,
Rhyncospora glomerata,
Eriophorum Virginianum,
Carex Atlantica,
[1] *Carex alata*,
Juncus marginatus,
Aletris farinosa,
Xyris flexuosa,
Pogonia ophioglossoides,
Limnodorum tuberosum,
Drosera rotundifolia,
Polygala cruciata,
Bartonia tenella,
Aster Novæ-Belgi,
Eupatorium verbenæfolium.

Some of the above plants are frequently met with in bogs here and there throughout the State, but almost all are common to the pine-barren regions of lower New Jersey. How they got into this little bog is an interesting question which is hard to solve.

[1] Collected by Mr. C. F. Saunders.

In addition to the above, the following plants are also found in this bog:

Paspalum laxe,
Carex interior,
Scleria Torreyana,
Juncus scirpoides,
Juncus dichotomus,
Alsine uliginosa,
Viola cucullata,
Viola blanda,
Viola primulæfolia,
Oxypolis rigida,
Gentiana saponaria,
Asclepias rubra,
Scutelaria integrifolia,
Campanula aparinoides,
Senecio balsamitæ,
Vernonia Novæ-boracensis.

The study of this flora has given rise to numerous questions regarding the origin and distribution of many species, some of which I shall endeavor to explain. The factors which influence the flora are soil, light, heat, water, wind, plants and animals.

(1) *Soil.*—The soil of this region, excepting the denser woods, is of a light brown or gray color, open and porous in texture and usually strewn on the surface with numerous pieces of the native rock. From its porous nature it cannot retain water, hence the plants have adapted themselves to this condition and usually have long roots. The absence of annuals in this region is striking. Out of a total of about 120 species, collected by me in 1899, but few were annuals. My collecting was confined mainly to those places where the indigenous flora is not influenced by the operations of man. Annuals are characterized by a fibrous root system, which is usually not very extensive. They are not, therefore, adapted for existence in this porous soil. Two of the annuals referred to, *Bidens comosa* and *Erechites hieracifolia*, were collected along roadsides, where they were partially protected from the sun and received a fair share of moisture in the rich soil of such locations. Another annual, *Gerardia tenuifolia*, of the dry woods, has small and very narrow leaves, and is thus fitted for existence under these conditions.

(2) *Light and Heat.*—The effect of these two factors on the distribution of plants is very marked. The elevations in this limited area do not perceptibly influence the prevailing temperature; but as the amount of light regulates, to a greater or less extent, the degree of heat or temperature, we will consider the two together.

Light has a marked effect on the area and texture of leaves; while it reaches its minimum in dense woods, it attains its maximum in the open and exposed locations. Between these two extremes there are many variations and each has its peculiar plants. In the minimum condition—that is, in dense woods—plants are characterized by broad, thin leaves; for instance, note the leaves of May-apple, *Podophyllum peltatum;* Indian turnip, *Arisæma triphyllum; Panicum Porterianum; Aster Lowrieanus; Aster macrophyllus*, and others, and compare these with the same or allied species growing in the sunlight. The first two, May-apple and Indian turnip, decided woodland plants, when growing in the open where woods have been recently cut off, are smaller in height and area of leafage. In the sunlight the leaves of most grasses and sedges are narrow, many of them are erect or placed edgewise, so as to receive a minimum of light. *Aster ericoides, Solidago bicolor, Euthamia Caroliniana, Helianthemum majus,* and others have all comparatively small leaves. Leaves of many plants in sunlight have protective coverings of hair or scales to prevent a too rapid evaporation of moisture. Others, particularly plants belonging to the *Leguminosæ*, have the power of changing their position when the light is too strong. On a cloudy day such leaves assume the usual position, but if the day is bright and the sun strong they turn on edge, close up or turn directly away from the sun.

While we notice that plants in the shade develop large leaves and long stems and that those in the sun are retarded in their development, we also note a tendency toward an optimum condition. Shade plants along edge of woods or around clearings in dense forests develop to a remarkable degree and have a strong directive tendency toward the light. Sun plants, on the other hand, dispute the ground with them, and an intense struggle for supremacy takes place. This battle-ground of the plants is common along roads in wooded districts. It is in this disputed territory of intermingling individual plants that differentiation begins and gives place to a variety of forms of species. As we recede from it to either extreme of light we encounter the well-marked species, specialized for adaptation to their particular surroundings.

(3) *Water.*—Water or moisture considered as food of plants has an important bearing on the development of plant life. On

this ridge its presence is not at once very evident. Rock-chestnut oak, post oak, black oak and beech, trees of rocky, sterile regions, are everywhere found. We have reason to believe that much moisture ascends through the porous subsoil by capillarity, enough at least to reach the plants peculiar to this soil. The moisture necessary to support the woodland plants is conserved through the aid of the thick covering of vegetable mould.

No streams cross the ridge, but, as described above, many take their rise along its base. There is a little bog at the southern base of the hill at Willow Grove, where Terwood Run takes its rise. The moisture here seems to ooze out from the base of the sandstone on to the loamy soil of the flanking formation on the south.

In studying the plants of this bog, I have been impressed with the comparatively smaller area of the leafage, and have come to the conclusion that abundant moisture does not necessarily imply an increased growth of leaves. A glance at the accompanying table will show the striking difference in this respect between typical plants of the woods and those of the bog.

Forest Plants.	Cm.	Sq. Cm.	Bog Plants.	Cm.	Sq. Cm
Agrimonia hirsuta	7 x 3.5	24.5	*Magnolia Virginiana* ...	11 x 5	55
Phryma Leptostachya. .	11 x 7	77	*Dulichium arundinaceum*	5 x .2	1
Viola pubescens.....	8 x 8	64	*Aletris farinosa*	13 x 1	13
Galium triflorum.....	3.5 x 1	3.5	*Drosera rotundifolia*	.5 x .1	2
Chimaphila maculata...	3 x 1.5	4.5	*Asclepias rubra*	13 x 4.5	52.5
Pyrola rotundifolia.....	4.5 x 4.5	20.25	*Scutellaria integrifolia*...	2.5 x .6	1.5
Galium lanceolatum.....	3.5 x 1.5	5.75	*Campanula aparinoides* .	2 x .5	1
Aralia nudicaulis.....	13 x 7.5	97.5	*Limnodorum tuberosum* .	15 x .5	7.5
Smilax herbacea.....	7 x 5	35	*Oxypolis rigidus*	1 x .3	1.2
Deringa Canadensis....	11 x 7	77	*Eupatorium verbenafolium*	7 x 2.5	17.5
Sanicula Canadensis....	7 x 3	21	*Aster Novæ-Belgi*	4 x .5	2
Panicum Porterianum..	8 x 2	16	*Polygala cruciata*	2 x .3	.6
Nabalus trifoliatus.....	10 x 7	70	*Gyrostachys cernua*.....	15 x 1.5	22.5
Viburnum acerifolium..	8 x 8	64	*Eriophorum Virginicum* .	30 x .3	9
Lycopus Virginicus....	8 x 3	24	*Scleria Torreyana*	12 x .2	2.4
Chelone glabra.....	9 x 3.5	31.5	*Xyris flexuosa*	21 x .1	2.1
Aster Lowrieanus.....	7 x 3.5	24.5	*Panicum sphagnicolum* .	4 x .4	1.6
Aster macrophyllus.....	16 x 12	192	*Rhyncospora glomerata* .	12 x .1	1.2
Podophyllum peltatum..	15 x 10	150	*Eleocharis tuberculosa* ...	10 x .02	.2
Arisæma triphyllum....	10 x 5	50	*Gentiana saponaria*	4 x 1	4
Sanguinaria Canadensis.	12 x 7	84	*Alsine uliginosa*	1 x .4	.4
Total area		1136	Total area		198.2
Average of 21 species..		54.1	Average of 21 species ..		9.4

In making these measurements, I took the average-sized leaf—in the case of pinnate leaves, one leaflet—and multiplied its length by its breadth in centimeters. The result, though not the exact area of the leaf, is approximate enough to show comparative values.

The average area of the leaves of the swamp plant is 9.4 sq. cm., while that of the forest plant is 54.1 sq. cm., or a ratio of nearly 1 to 6.

Conversely, this also proves that the large leaves of the woodland plants are the result of a lack of light, as noted above, and not a lack of moisture, since this element is usually present in such localities.

It can also be shown by comparing typical bog plants with typical dry-soil plants, that the size of the leaves is not dependent upon the amount of moisture.

Here are a few plants of each class:

Bog Plants (Hyprophytes).	Dry-Soil Plants (Xerophytes).
Pogonia ophioglossoides,	*Pogonia verticillata,*
Panicum sphagnicolum,	*Panicum nitidum,*
Scleria Torreyana,	*Scleria pauciflora,*
Aster Novæ-Belgi,	*Aster ericoides,*
Juncus marginatus,	*Juncus buffonius,*
Viola cucullata,	*Viola communis,*
Asclepias rubra,	*Asclepias syriacus,*
Carex interior.	*Carex virescens.*

There is practically no difference in the size or structure of the leaves of the two groups. Many other plants of either group not related to each other might be quoted as having features common to both, but I have only chosen in the above list the allied species. As a rule, the root system of the bog plant is extensive, but it is not more so than that of the dry-soil plant. The roots of the dry-ground plants have further and deeper to go in order to get sufficient moisture, hence their system is more extensive and much greater than that of the bog plant. A familiar instance of this outside of the region under discussion is that of the root systems of the sand-binding plants of the coast sand dunes, plants which live under rigorous xerophytic conditions.

This difference of root systems constitutes the only difference between the bog plants and the dry-soil plants of the Willow Grove hill. In the first, the food is abundant and close at hand, and the system compact; in the other, the food is scarce, and the system extended. I have therefore concluded that the swamp

plants are nothing more or less than xerophytes in moist surroundings, or *vice versa*.

(4) *Wind.*—Wind is an important factor in distributing plants. Seeds of many of the plants of this region are provided with wings or hairs by means of which they are blown considerable distances.

(5) *Plants.*—The rich vegetable mould of the woods and other places support plants which cannot exist where this factor is absent. In the woods north of the road on top of the Willow Grove hill, the vegetation is well developed. In the deeper recesses may be found the colorless and leafless saprophytes, *Monotropa uniflora*, *Hypopitys Hypopitys*, *Aphyllon uniflora* and *Leptamnium Virginianum*, also the plants in table above. The change of this flora as a result of the removal of vegetable mould may be seen a little southeast of the above point on Huckleberry Hill. Here the woods have been cut off, the slope is steep and the elements have done their work too well. Vegetation is scant, and stunted second-growth trees and shrubs give but little shade to the few clumps of wiry grasses, sedges, huckleberries and a few other flowering plants. Sphagnum moss in the bog supports small plants like *Drosera rotundifolia* and *Polygala cruciata*.

(6) *Animals.*—The distribution of plants is effected by insects in aiding cross-fertilization and by birds, squirrels and other animals in distributing seeds selected as food.

A summary of my observations shows that there is a distinct ridge having a peculiar geological structure and a flora different from that of the surrounding country; that perennials as a rule are only fitted to exist in the porous soil; that the large thin leaves of the wood plants are the result of a lack of light and not of nourishment; that variation of species commences in the optimum condition of light, and that the distinct forms are found in the extremes of this element; that the abundant moisture of the bog does not tend to develop much vegetable growth, and that the difference of structure of swamp plants and dry-soil plants is slight or none at all; that all the factors of soil, light, heat, water, wind, plants and animals regulate the distribution of the plants into three well-marked societies, the first two depending on the amount of light and the third on the amount of available moisture.